Docket No. 2565-0136P

Application No. 09/202,070

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PATENT
2565-0136P

IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of		Before the Board of Appeals	
	Shusou WADAKA, et al.	Appeal No.:	
Appl. No.:	09/202,070	Group:	2834
Filed:	December 8, 1998	Examiner:	M. Budd
For:	FILM ACOUSTIC WAVE DEVICE AND ITS MANUFACTURING METHOD AND CIRCUIT DEVICE		

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BRIEF FOR APPELLANT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This appeal is from the decision of the Primary Examiner dated March 18, 2002, finally rejecting claims 2-14 and 42-62, which are reproduced as an Appendix to this brief. This brief if being filed in triplicate with the requisite fee.

The commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to deposit account 02-2448.

I. Real Party in Interest

The named inventors have assigned their rights to the invention that is disclosed in the application and any patent that may issue therefrom to Mitsubishi Denki Kabushiki Kaisha, as recorded in the Patent and Trademark Office at Reel 9925, Frame 0240.

II. Related Appeals and Interferences

To the best of the knowledge of the undersigned, there are no other appeals or interferences known to the Appellants, the Appellants' representatives, or the above noted assignee that will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. Status of the Claims

Claims 2-14 and 42-62 are currently pending in the application. Claims 47-62 have been withdrawn from consideration. Claims 2-14 and 42-46 are rejected and the subject of the appeal. Claims 42 and 45 are the sole independent claims of the subject of the appeal.

IV. Status of Amendments

There were no amendments filed subsequent to the final rejection.

V. Summary of the Invention

The present invention pertains to the formation of acoustical wave devices on a silicon wafer. In the production of the acoustical wave devices variations of the type of material and the size of the material (i.e. thickness, length) will change the operation of the acoustic wave device and specifically the frequency ranges achieved by each device. Since the acoustical wave devices are produced on a micro scale, a plurality of these devices may be

produced on a single wafer. Commonly in the production of devices using semiconductor device fabrication technology, variations in the material, particularly thickness of the material, are generally observed in relation to the location of the device on the wafer. For example, due to the application techniques of metal layers (called sputtering), these layers are thicker towards the center of the wafer and become thinner towards the edge of the wafer.

In the production of the acoustic wave devices it is desirable to produce devices located on the same wafer so that each of these devices operated at the same frequency range. However, because of the variations in material, as discussed above, the frequency ranges vary depending on where the acoustical wave device is located on the wafer. Adjusting the material thickness at the different locations for the devices which are not producing the correct frequency range, becomes very costly and burdensome. Therefore, according to the present invention, the variation of thickness is compensated for by changing a characteristic of the pattern shape of the acoustical wave device, dependent upon where the acoustical wave device is positioned on the wafer during production.

Therefore, appellants recite in claim 42, a wafer having a plurality of acoustical wave devices formed thereon and exhibiting common operational characteristics, each of said acoustical wave devices comprising: a ground electrode formed on the wafer; a piezoelectric thin film formed on the ground electrode, wherein the piezoelectric thin film varies in at least one characteristic across the wafer; and at least one upper electrode formed on the piezoelectric thin film; wherein at least the ground electrode, the piezoelectric thin film and the at least one upper electrode form components in each of the plurality of acoustical wave devices; and wherein at least one component in some of the plurality of acoustical wave devices is modified in its operational characteristic to compensate for the variation in the at least one characteristic of the

piezoelectric thin film and is based on the location of the at least one acoustical wave devices on the wafer.

Further, appellants recite in claim 45, a plurality of acoustical wave device chips formed from a common wafer, each chip comprising: a ground electrode formed on the wafer; a piezoelectric thin film formed on the ground electrode, wherein the piezoelectric thin film varies in at least one characteristic across the wafer; and at least one upper electrode formed on the piezoelectric thin film; wherein at least the ground electrode, the piezoelectric thin film and the at least one upper electrode form components of the plurality of acoustical wave devices; and wherein at least one component in at least some of the plurality of acoustical wave devices is modified in its operational characteristic to compensate for the variation in the at least one characteristic of the piezoelectric thin film and is based on the location of the at least one acoustical wave devices on the wafer.

An aspect of the present invention may be gleaned from Figs. 1-3 in which the width (*We, Wa*) and length (*Le, La, Lg*) of the various components that comprise the acoustical wave device are illustrated and varied depending on where the acoustical wave device is positioned on the wafer. As an example of different pattern changes, the bonding pads connected to the upper electrodes of the acoustic wave devices in the center of the wafer may be longer than the bonding pads of acoustical at the edge of the wafer. Further, the upper electrodes may be narrower on the acoustical wave devices in the center of the wafer than the upper electrodes of acoustical wave devices at the edge of the wafer. Thus, a higher yield of acoustical wave devices having the same frequency characteristics is achieved.

VI. <u>The Issues</u>

The final Office Action presents four issues for review on Appeal.

1. Whether claims 2-14 and 42-46 are properly rejected under 35 U.S.C. § 102(a) as being anticipated by Krishnasawamy (U.S. Patent No. 5,185,589).
2. Whether claims 2-14 and 42-46 are properly rejected under 35 U.S.C. § 102(a) as being anticipated by Curran (U.S. Patent No. 3,401,275).
3. Whether claims 2-14 and 42-46 are properly rejected under 35 U.S.C. § 102(a) as being anticipated by Vale et al. (U.S. Patent No. 5,194,836).
4. Whether claims 2-14 and 42-46 are properly rejected under 35 U.S.C. § 102(a) as being anticipated by Japanese Patent Application No. 5-259804.

VII. <u>Grouping of the Claims</u>

For purpose of this appeal, Appellants consider the claims to not stand or fall together. Each claim is argued independently.

VII. <u>Argument</u>

A. <u>The References Relied Upon in the Rejection</u>

1. Krishnaswamy et al. (U.S. Patent No. 5,185,589)

The Krishnaswamy reference pertains to a film bulk acoustic resonator. The bulk resonator is a series of three acoustic resonators located next to each other. It is designed to eliminate the need for wire bonds that are usually provided to attach the bulk resonator to associated circuitry. Krishnaswamy accomplishes this by using a coplanar transmission line configuration which also provides means for grounding the bulk resonator. The configuration utilizes ground plane strips and via holes at appropriate positions in the ground plane strips in its design. Thus, a true ground connection to the resonator is provided without the need for vias passing through the substrate.

2. Curran et al. (U.S. Patent No. 3,401,275

The Curran reference pertains to piezoelectric resonators for use in high frequency filter circuits. The resonator utilizes a piezoelectric driving element which is less than one-half the wavelength of the operational frequency. The resonator is constructed on a wafer. The resonator has a bottom electrode formed on the wafer, the piezoelectric driving element formed on the bottom layer and an upper electrode formed on the driving element. The change in the thickness of the piezoelectric driving element provides for high frequency operation, allows for operation at even and odd harmonics and mass loads the active region of the resonator.

3. Vale et al. (U.S. Patent No. 5,194,836

The Vale reference pertains to a miniature thin film filter device. The thin film device is made up of a number of resonators each having the same structure. The resonator structure provides for a bottom electrode, a piezoelectric layer formed on the bottom electrode and an upper electrode formed on the piezoelectric material. The resonators are formed in rows in which the resonators are connected in cascade. The rows of resonators are connected in parallel to adjacent rows thus forming the high frequency filter bank. The ability to make the filters on a small scale allows for the filters to be manifolded without utilizing manifolding circuitry which usually cause significant filter losses.

4. Japanese Patent Application No. 5-259804

The JP 5-259804 reference pertains to an ultra thin plate multi-stage cascade connection of multiplex mode filters. Divided electrodes, which are formed on a plate oscillation portion, are varied in shape, including height and length. The shape of the electrodes is chosen based on the spurious radiation pattern in each of the divided electrodes. When the optimal radiation pattern is achieved, the radiation patterns of the divided electrodes will cancel each other minimizing the spurious radiation levels.

B. Claims 42 and 45 are not properly rejected under 35 U.S.C. § 102(a) as being anticipated by Krishnasawamy.

In the rejection of the claims, the Examiner alleges that each reference teaches the claimed structures. The Examiner further alleges that the recitation of "wherein at least one component in some of the plurality of acoustical wave devices is modified in its operational characteristic to compensate for the variation in the at least one characteristic of the piezoelectric thin film and is based on the location of the at least one acoustical wave devices on the wafer" in claims 42 and 45 provides no patentable weight to the claims. The Examiner states that "each reference obviously designs the resonator chips with a final frequency in mind and then fine tunes the device to compensate for the deviation in manufacture. Once the final tuning is achieved one cannot tell where metal was deleted or added or how much. Thus, the statement referring to the desire to adjust the final frequency based on wafer position is meaningless." The Examiner has failed, however, to appreciate the article to which the claims are directed. In essence the Examiner concludes that the invention to which this application is directed is obvious from prior art commensurate in teachings to that discussed in the background section of the present application. As discussed further below, the Examiner basis his rejection on the acoustic wave device itself instead of examining the claims based on what they recite i.e., " a wafer" and "a plurality of acoustical wave device chips formed from a common wafer."

Claim 42 recites, *inter alia,* a wafer having a plurality of acoustical wave devices formed thereon and exhibiting common operational characteristics.

Claim 45 recites, *inter alia,* a plurality of acoustical wave device chips formed from a common wafer.

The Krishnasawamy reference teaches the creation of a film bulk resonator. The film bulk resonator is made up of three resonators formed on a substrate. Each resonator is identical, they each have the same characteristics and dimensions of features.

In a proper examination of the claims, the claims may not be read to cover a single final resonator as asserted by the Examiner. As evidenced above, claim 42 is claiming a wafer having a plurality of acoustical wave devices formed thereon wherein at least one component of the acoustical wave device is modified in its operation characteristic dependent upon the location of the acoustical wave device on the wafer and claim 45 is claiming a plurality of acoustical wave device chips formed from a common wafer wherein at least one component of the acoustical wave device is modified in its operation characteristic dependent upon the location of the acoustical wave device on the wafer. The teachings of Krishnasawamy are concerned with the individual film bulk resonators and not the formation of the resonators on a wafer as provided in Appellants' claims.

Further, in disregarding the limitation of providing at least one variation of the piezoelectric thin film based on the location on the wafer of the acoustical wave device as recited in the claims, the Examiner is omitting an essential structural element as it pertains to the claims. Appellants respectfully submit that language identifying the physical location suggests a structural element. In looking at the independent claims as a whole, it is the dependence on where the various piezoelectric thin films are located on the wafer, which determines how each piezoelectric thin film is created. Therefore, the position of the pattern is just as much a structural element as the pattern itself, the shape of the pattern, the piezoelectric thin film, the ground electrode etc.

A proper rejection under 35 U.S.C 102 requires each element of the claim be taught by the applied reference. MPEP 2131 states:

> A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. The identical

> invention must be shown in as complete detail as contained in the . . . claim.

As provided above, it is illustrated that Krishnaswamy does not teach each and every element of independent claims 42 and 45. In reference to claim 42, Krishnaswamy fails to teach a wafer on which a plurality of acoustically wave devices are fabricated and varied in the fabrication based on the location of the acoustic wave device on the wafer. Further, in regard to claim 45, Krishnaswamy fails to teach a plurality of acoustic wave chips formed from a common wafer on which a plurality of acoustically wave devices are fabricated and varied in the fabrication based on the location of the acoustic wave device on the wafer. Therefore, a reversal of the rejection of the claims under 35 U.S.C. § 102 should be granted.

C. <u>Claims 42 and 45 are not properly rejected under 35 U.S.C. § 102(a) as being anticipated by Curran et al.</u>

For the same reasons as set forth above Curran fails to disclose the features of Appellants' independent claims 42 and 45. Curran teaches a piezoelectric resonator that is designed for use in high frequency filter circuits. In Curran it states that improved coupling may occur by sizing the relative thickness of the piezoelectric element and the substrate. See column 1, lines 68-72. It further states that the thickness of the driving element is selected to have a fundamental frequency corresponding to 1/n times the frequency at which the resonator is to be operated. See column 3, line 54-56.

First, we are again discussing a single acoustic wave device and not a plurality of acoustic wave devices formed on or from a single wafer. Second, it is known that changing the various dimensions of the elements of an acoustic wave devices changes it's manner of operation and thus specific frequencies may be achieved by modifying the features of acoustic wave devices. However,

the techniques for fabricating acoustic wave devices on a single wafer create variations in the thickness, for example, of sputtered metal across the wafer. Therefore, in the present invention, based on the location of the device on the wafer, modifications to the acoustic wave devices are built into the fabrication process so that each device will achieve the same characteristics and operational frequency. Therefore, it is unnecessary to make manual changes to the acoustic wave device after fabrication in order to achieve the desired characteristics and operational frequency. Curran does not suggest this or provide these advantages.

Curran does not teach a wafer having a plurality of acoustic wave devices formed thereon in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 42. Further, Curran fails to teach a plurality of acoustical wave device chips formed from a common wafer in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 45.

As provided above, it is illustrated that Curran does not teach each and every element of independent claims 42 and 45. Therefore, a reversal of the rejection of the claims under 35 U.S.C. § 102 should be granted.

D. Claims 42 and 45 are not properly rejected under 35 U.S.C. § 102(a) as being anticipated by Vale et al.

For the same reasons as set forth above Vale fails to disclose the features of Appellants' independent claims 42 and 45. Vale teaches an acoustic filter device that is made up of a number of resonators which are formed on the same dielectric membrane. The structure of the acoustic resonators is the same for each resonator. See column 2, lines 31-34. The acoustic filter device is a one of many devices constructed upon a substrate. See column 2, lines 20-22.

Therefore, the teachings of Vale revolve around a single device comprised of multiple resonators, each having the same structure. Vale does not teach a wafer having a plurality of acoustic wave devices formed thereon in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 42. Further, Vale fails to teach a plurality of acoustical wave device chips formed from a common wafer in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 45.

As provided above, it is illustrated that Vale does not teach each and every element of independent claims 42 and 45. Therefore, a reversal of the rejection of the claims under 35 U.S.C. § 102 should be granted.

E. Claims 42 and 45 are not properly rejected under 35 U.S.C. § 102(a) as being anticipated by Japanese Pat. App. No. 5-259804.

For the same reasons as set forth above JP 5-259804 fails to disclose the features of Appellants' independent claims 42 and 45. JP 5-259804 teaches a filter having divided electrodes that are provided in various shapes to change the characteristic of the filter. Again, however, it is the individual device that is modified in order to accomplish a desired characteristic. The device is not a wafer, nor is a plurality of device chips formed from a single wafer.

Thus, JP 5-259804 does not teach a wafer having a plurality of acoustic wave devices formed thereon in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 42. Further, JP 5-259804 fails to teach a plurality of acoustical wave device chips formed from a common wafer in which the acoustic wave device is modified based on it's location on the wafer as provided in claim 45.

As provided above, it is illustrated that JP 5-259804 does not teach each and every element of independent claims 42 and 45. Therefore, a reversal of the rejection of the claims under 35 U.S.C. § 102 should be granted.

F. Features of the Dependent Claims are also not taught by Krishnaswamy, Vale et al., Curran et al, or JP 5-259804.

Features of the dependent claims are also not taught by the provided references for the reasons set forth above. In regard to claim 2, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein a length of the at least one upper electrode is dependent upon the position at which the film acoustic wave device is mounted on the wafer." None of the references teach or suggest changing the length of the upper electrode based on the location of the acoustical wave device on the wafer from which it was fabricated.

In regard to claim 3, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein a width of the upper electrode is dependent upon the position at which the film acoustic wave device is mounted on the wafer." For the same reasons set forth in claim 2, none of the applied references teach or suggest changing a characteristic, let alone a specific characteristic of an acoustical wave device based on its fabricated position on a wafer.

In regard to claim 4, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "a plurality of upper electrodes, wherein distances between each of the plurality of upper electrodes are dependent upon the position at which the film acoustic wave device is mounted on the wafer." For the same reasons set forth above, the distance between electrodes is not taught or suggested by the references based on the location of the acoustical wave device on the wafer.

In regard to claim 5, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "a bonding pad for connecting with the at least one upper electrode, wherein the pattern shape of the film acoustic wave device is formed by at least the ground electrode, the piezoelectric thin film, the at least one upper electrode, and the bonding pad, and <u>wherein a shape of the bonding pad is dependent upon the position at which the film acoustic wave device is mounted on the wafer</u>." (emphasis added)

In regard to claim 6, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "a connecting pattern for connecting the upper electrode with the bonding pad, wherein the pattern shape of the film acoustic wave device is formed by at least the ground electrode, the piezoelectric thin film, the at least one upper electrode, the bonding pad, and the connecting pattern, and wherein a shape of the connecting pattern is <u>dependent upon the</u>

position at which the film acoustic wave device is mounted on the wafer." (emphasis added)

In regard to claim 7, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose " wherein the connecting pattern forms an air bridge."

In regard to claim 8, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "a capacitor provided on the same wafer as the film acoustic wave device, wherein a capacitance of the capacitor is dependent upon the position at which the film acoustic wave device is mounted on the wafer." (emphasis added)

In regard to claim 9, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the wafer is made of gallium arsenide (GaAs), the piezoelectric thin film is made of lead titanate ($PbTiO_3$), and at least one upper electrode is a conductor substantially made of platinum (Pt)."

In regard to claim 10, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the wafer is made of silicon (Si), the piezoelectric thin film is made of lead titanate ($PbTiO_3$), and at least one upper electrode is a conductor substantially made of platinum (Pt)."

In regard to claim 11, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the piezoelectric thin film is made of PZT ($PbTiO_3$-$PbZrO_3$), and at least one upper electrode and the ground electrode is a conductor substantially made of platinum (Pt)."

In regard to claim 12, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the piezoelectric thin film is made of zinc oxide (ZnO)."

In regard to claim 13, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the piezoelectric thin film is made of aluminum nitride (AlN)."

In regard to claim 14, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "an inductor positioned between the wafer and the ground electrode."

In regard to claim 43, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the varied characteristic of the piezoelectric thin film is thickness."

In regard to claim 44, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the piezoelectric thin film is thicker in the middle of the wafer and becomes thinner as it extends out towards the periphery of the wafer."

In regard to claim 46, Krishnaswamy, Vale, Curran and JP 5-259804 each fail to suggest or disclose "wherein the varied characteristic of the piezoelectric thin film is thickness."

Therefore, Krishnaswamy, Vale, Curran and JP 5-259804 each do not teach the claimed features as recited in Appellants' claimed combinations.

IX. Conclusion

Based on the reasons set forth above, the rejections of claims 2-14 and 42-46 under 35 U.S.C. §102 should be REVERSED. As shown in the foregoing arguments, the claimed features of the present invention are not disclosed or suggested in the cited documents. As such, the documents do not anticipate the claimed invention. Accordingly, since the rejection of the claims is improper, reversal of the rejection is respectfully requested.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. 1.16 or under 37 C.F.R. 1.17; particularly, extension of time fees.

Respectfully submitted,

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